

Vascular Organization of the Rhizome of *Cibotium barometz*SUBHASH CHANDRA¹

Cibotium is a genus of about a dozen species distributed in southeastern Asia, Hawaii, and Central America. Some of the species are large and rather resemble tree ferns. *Cibotium barometz* is a graceful, large, Malaysian fern with a stump-like rhizome 5–8 cm. in diameter that appears much stouter because of its crowded, persistent leaf bases. Its rhizome is the "Vegetable Lamb" or "Scythian Lamb" of the Orient. The rhizome, which is densely clothed with large, tufted, golden brown hairs and hence appears like a woolly lamb, is semi-erect and bears a crown of large, bipinnate fronds 2–3 m. long that are covered with similar hairs at their base. These profusely produced hairs are used for stuffing cushions and pillows and are reputed to staunch a bleeding wound.

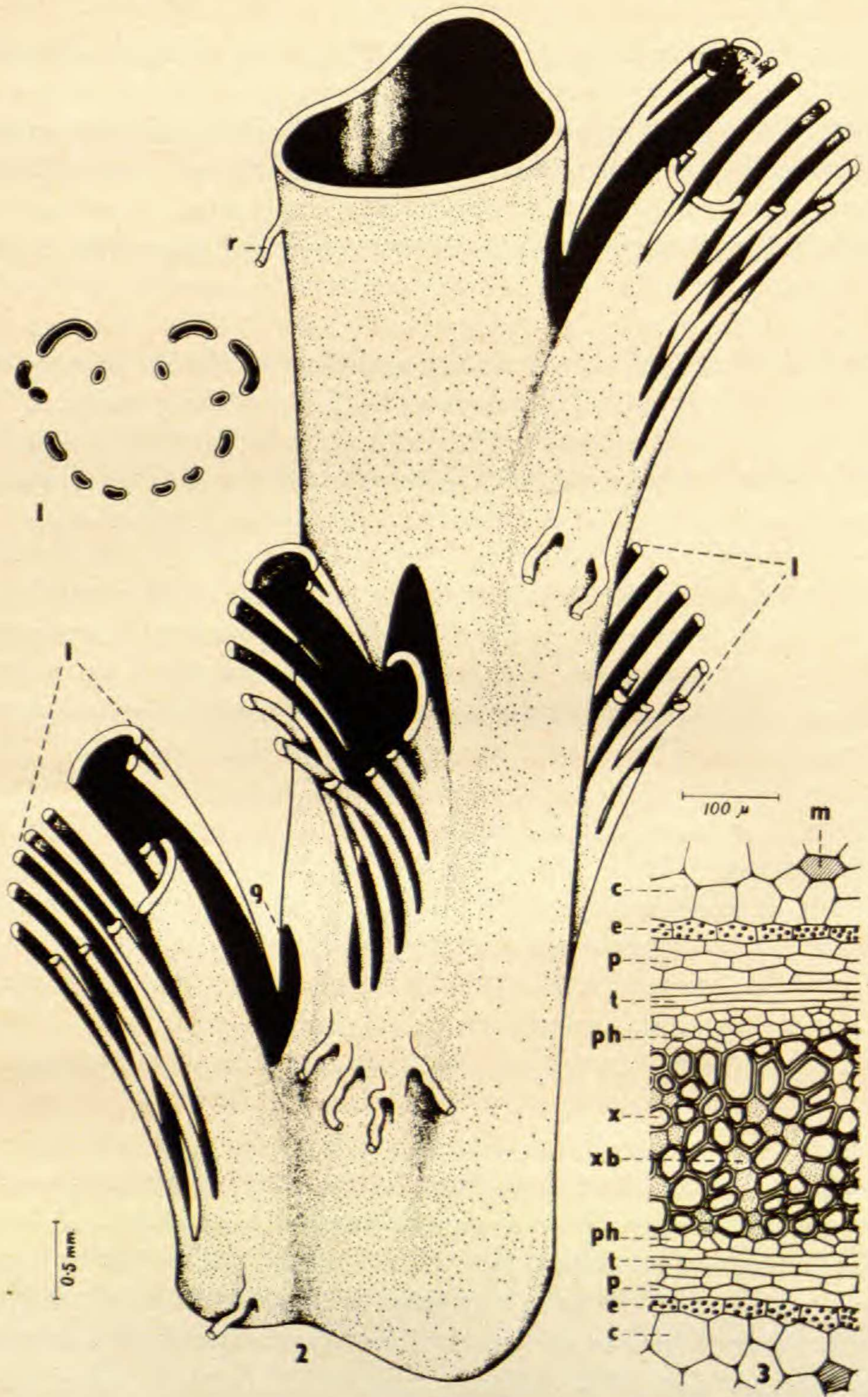
Most pteridologists believe *Cibotium* is cyatheoid (Mettenius, 1856; Diels, 1899; Manton, 1958; Holttum and Sen, 1961; Nayar, 1970), but others think it is related to the dennstaedtioid ferns (Bower, 1926; Christensen, 1938; Copeland, 1947). The anatomy of the Cyatheaceae, including some of the species of *Cibotium*, has been studied recently by Holttum and Sen (1961) and by Sen (1964), who have pointed out the significance of rhizome anatomy in assessing the phylogenetic relationships of these ferns. Some aspects of the anatomy of *C. barometz* were reported by Ogura (1926, 1930), and some details of the vascular organization were discussed by Hayata (1929). On the basis of the stelar structure, the latter separated *C. barometz* as a subgenus, *Microcibotium*.

This study is based on material collected from Naphuk, Assam (*P. & S. Chandra* 72165, LWG). The anatomy was studied from microtome sections of material fixed in F.A.A., stored in 70% ethyl alcohol, and stained with combinations of safranin and either fast green, sudan IV, or iodine.

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The rhizome is soft and is bounded by a thin-walled epidermis; 20–30 layers of hypodermal cells form a sheath composed of narrow, slightly elongated cells having faintly thickened walls. The ground tissue cells are thin-walled and parenchymatous, and contain dense starch deposits. Numerous cells containing mucilage are scattered in the parenchyma. The vascular cylinder (*Fig. 2*) is a large solenostele (the pith is often 4–6 cm. in diameter) pierced by small, subovate, spirally arranged leaf gaps (*Fig. 2, g*); because the leaves are crowded, the leaf gaps are often so closely placed that the vascular cylinder approaches the dictyostelic condition. No medullary vascular tissue is found. Each leaf (*Fig. 2, l*) is supplied by a large, corrugated, gutter-shaped vascular strand given off from the lower end of the leaf gap. Before separation from the stelar cylinder, the leaf trace forms a broad, prominent, hollow, outward protrusion which extends some distance below the leaf gap. These protrusions make the cylinder irregularly corrugated. The leaf trace bundle, although a solitary band at its origin, divides into a large number of narrow strands before entering the leaf base. The strands are arranged in the form of an open gutter with incurved margins and a longitudinal, lateral invagination near each adaxial margin. The strands are disposed in three groups (*Fig. 1*). One forms a broad, abaxial arch with incurved margins facing the center; the other two are smaller, adaxial, more sharply curved arches with the concavity facing away from the center. The leaf trace maintains this shape as it passes up the stipe. The roots are mostly associated with the leaves, and the root traces are given off in clusters (*Fig. 2, r*) just before the leaf trace separates from the stelar cylinder.

The xylem tissue of the vascular cylinder is composed of 6–12 layers of broad, short, scalariform tracheids interspersed with narrow, ribbon-like, interconnected bands one cell thick that are mostly arranged radially and composed of thin-walled xylem parenchyma cells. Phloem surrounds the xylem on either side as a thin layer composed of two or three layers (one or two only on the abaxial side). The phloem consists of narrow, thin-walled tracheids mixed with parenchyma cells. There is a peripheral



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layer 3-5 cells broad of tangentially much elongated, narrow, thin walled cells (*Fig. 3*, t) surrounding the phloem, as is characteristic of the cyatheoid ferns (Holtum and Sen, 1961; Sen, 1964). These cells stain deeply with fast green, are devoid of nuclei, and possess scattered sieve areas on all walls (Ogura, 1927; Holtum and Sen, 1961; Sen, 1964). This layer of tangential cells gives a characteristic appearance to the vascular cylinder in cross-section. The pericycle is two- or three-layered. The endodermis is poorly differentiated, but is demarcated from the much larger cells of the ground tissue. Cubical cells and sclerenchymatous bands, as reported in some of the Cyatheaceae (Holtum and Sen, 1961), are absent. The leaf trace bundle is structurally similar to the main vascular cylinder, but the xylem tissue is thinner and contains only 1-3 layers of tracheids; tangential cells are absent, and the endodermis is better differentiated.

Vascular anatomy of the rhizome of *C. barometz* lends support to the hypothesis that it is related to the cyatheoid ferns. The leaf trace bundle and its relationship to the main stelar cylinder are similar to those reported in *Cyathea* and related genera. The characteristic tangential cells surrounding the phloem tissue in *C. barometz* are paralleled in the cyatheaceous genera and constitute a characteristic anatomical feature of that group, but are not found in the dennstaedtioid ferns. Also, the vascular cylinder of *C. barometz* is radially symmetrical with spirally arranged leaf gaps, as in the cyatheoid ferns, in contrast to the dorsiventral stele of the dennstaedtioids (Kaur, 1962; Nayar and Kaur, 1963a, b), which have the leaf traces arranged in two dorsal rows, with leaf gaps lateral to them on the side facing the median plane of the rhizome.

FIG. 1. CROSS-SECTION OF VASCULAR STRANDS AT LEAF BASE. FIG. 2. PORTION OF STELAR CYLINDER OF THE RHIZOME. FIG. 3. CROSS-SECTION OF A PORTION OF THE VASCULAR CYLINDER OF THE RHIZOME. The abbreviations are: c = CORTICAL CELL, e = ENDODERMIS, g = LEAF GAP, l = LEAF TRACE, m = MUCILAGE-CONTAINING CELL, p = PERICYCLE, ph = PHLOEM, r = ROOT, t = TANGENTIAL CELL, x = XYLEM, xb = XYLEM PARENCHYMA BAND.

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